

## PATENT COOPERATION TREATY

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## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

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in its capacity as elected Office

<b>Date of mailing (day/month/year)</b> 13 October 2000 (13.10.00)	
<b>International application No.</b> PCT/SE00/00424	<b>Applicant's or agent's file reference</b> LH/Ru 43144
<b>International filing date (day/month/year)</b> 03 March 2000 (03.03.00)	<b>Priority date (day/month/year)</b> 08 March 1999 (08.03.99)
<b>Applicant</b> DELLDÉN, Lars, Håkan	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

05 September 2000 (05.09.00)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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10/030373

## PATENT COOPERATION TREATY

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 23 MAR 2001

PCT

14

Applicant's or agent's file reference LH/Ru 43144	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE00/00424	International filing date (day/month/year) 03.03.2000	Priority date (day/month/year) 08.03.1999
International Patent Classification (IPC) or national classification and IPC <sub>7</sub> B 04 B 13/00 // B 04 B 1/10		
Applicant Alfa Laval AB et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of \_\_\_\_\_ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 05.09.2000	Date of completion of this report 06.02.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Göran Carlström/CF Telephone No. 08-782 25 00

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00424

**I. Basis of the report****1. With regard to the elements of the international application:\***☒ the international application as originally filed☐ the description:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the claims:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, as amended (together with any statement) under article 19

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the drawings:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the sequence listing part of the description:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**These elements were available or furnished to this Authority in the following language English which is:☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).☒ the language of publication of the international application (under Rule 48.3(b)).☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:**☐ contained in the international application in written form.☐ filed together with the international application in computer readable form.☐ furnished subsequently to this Authority in written form.☐ furnished subsequently to this Authority in computer readable form.☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.**4. ☐ The amendments have resulted in the cancellation of:**☐ the description, pages \_\_\_\_\_☐ the claims, Nos. \_\_\_\_\_☐ the drawings, sheet/fig \_\_\_\_\_**5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/00424

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

## 1. Statement

Novelty (N)	Claims	<u>1-13</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-13</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-13</u>	YES
	Claims		NO

## 2. Citations and explanations (Rule 70.7)

The claimed invention is not considered to be anticipated by the patent documents cited. None of these documents reveals the centrifugal separator described in the claims. The invention according to claims 1-13 is therefore considered to be new, to involve an inventive step and to be industrially applicable.

JP 10272383 A (MITSUBISHI KAKOKI KAISHA)

US 4410318 A (J.E.G. BJÖRK ET AL)

US 4206871 A (V.R. NILSSON)



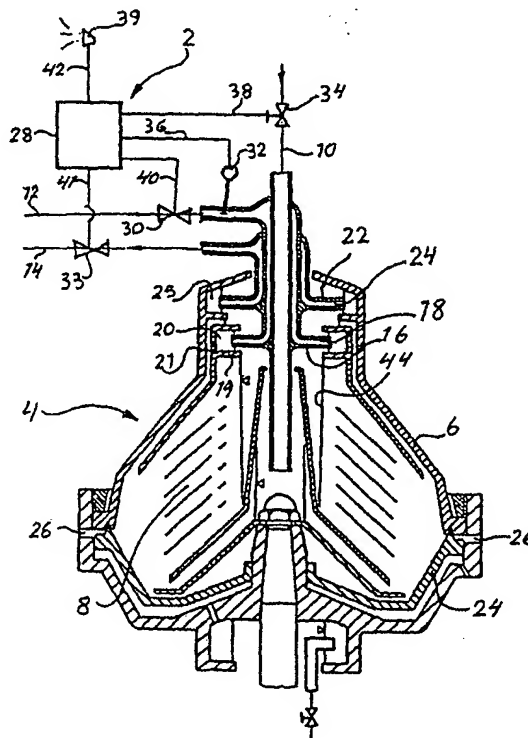
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/SE00/00424 (22) International Filing Date: 3 March 2000 (03.03.00) (30) Priority Data: 9900815-3 8 March 1999 (08.03.99) SE (71) Applicant (for all designated States except US): ALFA LAVAL AB [SE/SE]; S-147 80 Tumba (SE). (72) Inventor; and (75) Inventor/Applicant (for US only): DELLDÉN, Lars, Håkan [SE/SE]; S:t Paulsgatan 33A, S-118 48 Stockholm (SE). (74) Agents: HAGSTRÖM, Leif et al.; Bergenstråhle & Lindvall AB, P.O. Box 17704, S-118 93 Stockholm (SE).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	

(54) Title: METHOD AND DEVICE FOR INDICATING AN UNDESIRABLE OPERATION CONDITION OF A CENTRIFUGAL SEPARATOR

## (57) Abstract

An indication device (2) indicates an undesired operation condition of a centrifugal separator (4) and comprises an inlet valve (34) situated in a supply conduit (10) to the separator, and an outlet valve (30) situated in an outlet conduit (12) from the separator. During normal operation of the separator the valves are adjusted in open normal valve positions for passing normal flows through the supply and outlet conduits. A control unit (28) is adapted to activate a signal means (39) to generate an error signal in response to a pressure sensor (32) if the pressure sensor during a predetermined period of time during operation of the separator senses a course of pressure change in the outlet conduit (12) differing from an expected normal course of pressure change, when the inlet and outlet valves during a predetermined period of time are adjusted in valve positions which at least substantially decreases the flows in the supply and outlet conduits from said normal flows.



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METHOD AND DEVICE FOR INDICATING AN UNDESIRE OPERATION  
CONDITION OF A CENTRIFUGAL SEPARATOR

5 The present invention relates to a method and device for  
indicating an undesired operation condition of a centrifugal  
separator comprising a centrifugal rotor forming a separation  
chamber, a supply conduit for supplying a liquid mixture to  
be separated to the separation chamber, the liquid mixture  
10 containing at least two components, at least two outlets for  
discharging a separated component each out of the separation  
chamber, one outlet being arranged to discharge a separated  
liquid phase comprising one of the components, and an outlet  
conduit, the interior of which communicates with said one  
15 outlet.

An undesired operation condition of a centrifugal separator  
of the kind stated above can arise from different causes and  
is often difficult to discover, which can lead to that the  
20 centrifugal separator is operated with an impaired function  
during a longer period of time. One cause of an undesired  
operation condition is leakage through valves when these are  
to be completely closed. For example, the centrifugal se-  
parator can be provided with a sludge discharge means, which  
25 intermittently discharges accumulated separated sludge to-  
gether with liquid from the separation chamber with the aid  
of an axially moveable slide valve. Between the discharge  
movements the slide valve has to keep tight in order to have  
a boundary layer between separated liquid phases to form at  
30 an intended radial level in the separation chamber. With  
respect to the function of the centrifugal separator it is  
important that the formed boundary layer is at said radial  
level. If liquid escapes out of the separation chamber via  
the slide valve the boundary layer is formed at a radial  
35 level which is situated outside the intended radial level,  
which results in a changed undesired separation result. Since

the centrifugal rotor is surrounded by a stationary protective cover it is impossible to visually discover such a leakage.

5 SE-B-409 662 suggests a device for indicating leakage at such a centrifugal separator that intermittently discharges sludge. The known device comprises a vibration sensing piezoelectric crystal placed on the protective cover so that it is hit by possibly leaking liquid flow. When the  
10 piezoelectric crystal is hit by droplets thrown from the rotating centrifugal rotor it gives an electric signal which is used to activate an alarm device. However, the known device has not been practised, probably due to the fact that it has proved to be unreliable.

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For certain applications, for example cleaning of oil from minor amounts of water and sludge, the centrifugal separator may be provided with three outlets for discharging three components out of the separation chamber, namely a light  
20 phase outlet for a light component such as oil, a heavy phase outlet for a heavy component such as water and an outlet for a sludge component. If the amount of water outseparated is a small fraction of the amount of oil outseparated, usually the heavy phase outlet is provided with an intermittently opening  
25 valve for discharging accumulated heavy phase (water) in batches. For the same reasons as described above in connection with the centrifugal separator with an intermittently opening slide valve for discharging sludge the heavy phase outlet valve has to be tight between the opening movements in  
30 order to prevent the centrifugal separator from being operated at an undesired condition or to prevent loss of a valuable product.

For certain other applications, for example cleaning of



liquid mixtures from large amounts of sludge the centrifugal separator usually has a discharge means that continuously discharges separated sludge from the separation chamber by a plurality of nozzles, which are distributed around the centrifugal rotor at the radially outermost portion thereof. In this case an undesired operation condition of the centrifugal separator arises if the flow of sludge through the nozzles increases due to wear thereof, or if the sludge flow decreases due to clogging of one or more nozzles. Wear and clogging of the nozzles results in an impaired separation result.

An object of the present invention is to provide a reliable simple method of indicating an undesired operation condition of a centrifugal separator of the kind stated initially.

This object is obtained by a method which is characterised by: operating the centrifugal separator, sensing a normal operation pressure in the outlet conduit, when a normal flow of the liquid mixture prevails in the supply conduit and a normal flow of the liquid phase prevails in the outlet conduit, at least substantially decreasing the flow of the liquid mixture through the supply conduit from the normal flow of the liquid mixture during a predetermined period of time, at least substantially decreasing the flow of the liquid phase through the outlet conduit from the normal flow of the liquid phase during the same predetermined period of time, sensing the course of the pressure change in the outlet conduit from the normal operation pressure during the predetermined period of time, and generating an error signal in response to the sensed course of pressure change when this deviates from an expected normal course of pressure change.

The predetermined period of time should only comprise one or a few seconds.

When the centrifugal separator is new and existing valves and liquid nozzles are new the expected normal course of pressure change can easily be determined by empirical test. Alternatively, the course of pressure change can be determined by theoretical calculations.

Depending on the constitution of the centrifugal separator the expected course of pressure change can be determined for different conditions. For example, the flow of the liquid phase through the outlet conduit and/or the flow of the liquid mixture through the supply conduit or both flows may be shut off during the predetermined period of time.

When the second separated component constitutes sludge the second outlet of the centrifugal separator may be formed by a sludge discharge means for intermittent discharge of the sludge. In addition, the centrifugal rotor forms an outlet chamber for said one component and a paring disc forming said one outlet is arranged in the outlet chamber. In this case the error signal is suitably generated if the pressure in the outlet conduit decreases to a predetermined low pressure during the predetermined period of time. The predetermined low pressure is chosen such that if the sludge discharge means functions as expected and does not leak between discharge occasions, the pressure in the outlet conduit should not have time to decrease to the low pressure during the predetermined period of time.

The predetermined period of time, during which the course of pressure change in the outlet conduit is sensed, suitably begins as soon as the centrifugal separator has reverted to

an expected normal operation condition after a sludge discharge occasion.

Alternatively, the second outlet of the centrifugal separator may be formed by a sludge discharge means for continuously discharging the sludge. In this case, the error signal is suitably generated if the pressure in the outlet conduit decreases during the predetermined period of time at a rate that differs from an expected normal pressure decreasing rate. To prevent the pressure in the outlet conduit from decreasing to rapidly to the ambient pressure during the predetermined period of time the flow through the supply conduit should not be completely closed but be reduced to a known flow, preferably to a flow equal to the total flow through the nozzles during normal operation conditions with nozzles working correctly.

A further object of the present invention is to provide a simple reliable device for indicating an undesired operation condition of a centrifugal separator of the kind stated initially.

This further object is obtained by a device which is characterised by an inlet valve situated in the supply conduit and adjustable between open and closed conditions, an outlet valve situated in the outlet conduit and adjustable between open and closed conditions, the valves being adjustable in open normal valve positions for allowing normal flows to pass through the supply and outlet conduits during normal operation of the centrifugal separator, a pressure sensor for sensing the pressure in the outlet conduit upstream the outlet valve, a signal means for generating an error signal, and a control unit for activating the signal means to generate the error signal in response to the

pressure sensor sensing during a predetermined period of time during operation of the centrifugal separator a course of pressure change in the outlet conduit differing from an expected normal course of pressure change, when the inlet and outlet valves during the predetermined period of time are adjusted in valve positions which at least substantially decrease the flows in the supply and outlet conduits from the normal flows therein. For example, the outlet valve may be closed, or both the inlet valve and the outlet valve may be closed.

When the second one of the separated components is constituted by sludge, the second outlet of the centrifugal separator may be formed by a sludge discharge means for intermittent discharge of the sludge. The centrifugal rotor further forms an outlet chamber for said one component and a paring disc forming said one outlet is arranged in the outlet chamber. In this case, the control unit preferably activates the signal means to generate the error signal in response to the pressure sensor sensing during the predetermined period of time a pressure in the outlet conduit being below a predetermined pressure, which is lower than a normal operation pressure in the outlet conduit.

Alternatively, the second outlet of the centrifugal separator may be formed by a sludge discharge means for continuous discharge of the sludge. In this case the control unit preferably activates the signal means to generate the error signal in response to the pressure sensor sensing during the predetermined period of time a pressure in the outlet conduit which decreases at a rate differing from an expected normal pressure decreasing rate.

Advantageously, the control unit controls the inlet valve for

adjusting the valve position thereof, activates the signal means to generate the error signal, and locks the inlet valve in a closed valve position in response to the pressure sensor sensing during the predetermined period of time a course of pressure change in the outlet conduit differing to an unacceptably large extent from the expected normal course of pressure change. The expression "a course of pressure change in the outlet conduit differing to an unacceptably large extent" is intended to mean a course of pressure change indicating an operation condition of the centrifugal separator that does not give a satisfactory separation result or causes product losses. In this case the centrifugal separator should be taken out of operation for service or repair.

The control unit may also control the outlet valve for adjusting the valve position thereof.

Instead of adjusting the normal flows and reduced flows with the aid of the valves, of course the flows may also be adjusted in a different way for instance by controlling a supply pump.

The invention is described in more detail in the following with reference to the accompanying drawing, which shows a vertical cross-section through an intermittently sludge discharging centrifugal separator provided with a device according to an embodiment of the invention.

The drawing shows a device 2 according to the invention for indicating an undesired operation condition of a centrifugal separator 4, which in this example is intended for separating sludge and water containing oil into a light first component comprising oil, a heavy second component comprising water and

a heavy third component comprising sludge. The centrifugal separator comprises a centrifugal rotor 6 forming a separation chamber 8, a supply conduit 10 for supplying oil to be separated to the separation chamber 8, an outlet conduit 12 for discharging separated oil, and an outlet conduit 14 for discharging separated water. A stationary oil paring disc 16 forms an outlet 18 communicating with the interior of the outlet conduit 12 and extending radially into an annular oil outlet chamber 20, which is formed by a U-shaped wall portion 19 attached to the centrifugal rotor 6. From the bottom of the oil paring disc 20 a hole 21 extends through the wall portion 19. A stationary water paring disc 22 forms an outlet 24 communicating with the interior of the outlet conduit 14 and extending radially into an annular water outlet chamber 25, which is formed by the centrifugal rotor 6. An axially moveable slide valve 24 is adapted to intermittently open a passage to a number of sludge outlets 26 in the radially outermost portion of the centrifugal rotor 6.

The indication device 2 comprises a control unit 28 having electronic equipment for signal processing, an outlet valve 30 in the outlet conduit 12, a pressure sensor 32 for sensing the pressure in the outlet conduit 12 upstream the outlet valve 30, an outlet valve 33 in the outlet conduit 14, and an inlet valve 34 in the supply conduit 10. The pressure sensor 32 is connected to the control unit via a signal line 36. The inlet valve 34, outlet valve 30 and outlet valve 33 are connected to the control unit 28 via control lines 38, 40 and 41, respectively. A signal means 39 for generating an alarm signal is connected to the control means 28 via a signal line 42.

During normal operation of the centrifugal separator the liquid mixture consisting of sludge and water containing oil

is pumped via the supply conduit 10 through the inlet valve 34, which by the control unit 28 is adjusted in an open normal valve position, for instance completely open valve position, and further into the separation chamber 8. In the separation chamber 8 the oil in the liquid mixture is separated radially inwardly and flows to the oil outlet chamber 20, from which the oil flows further through the outlet 18 of the oil paring disc 16 and via the outlet conduit 12 through the outlet valve 30, which by the control unit is adjusted in an open normal valve position, for instance a completely open valve position. The hole 21 from the outlet chamber 20 may have a significant flow capacity.

The water in the liquid mixture separates in the separation chamber 8 radially outwardly and flows to the water outlet chamber 25, from which the water flows further through the outlet 24 of the water paring disc 22 and via the outlet conduit 14 through the outlet valve 33 likewise adjusted in an open normal valve position, for instance a completely open valve position. If the water content of the liquid mixture is low the water accumulated in the water paring chamber 25 may be discharged in batches by intermittent opening of the outlet valve 33.

Sludge in the liquid mixture separates radially outwardly in the separation chamber 8 and accumulates in the radially outermost part of the separation chamber 8. The slide valve 24 is intermittently opened at short moments, normally in intervals of one or more hours, whereby the accumulated sludge and remaining liquid in the separation chamber 8 are thrown out through the sludge outlets 26.

During normal operation the control unit 28 senses a normal operation pressure in the outlet conduit 12 with the aid of

the pressure sensor 32. As soon as the centrifugal separator 4 has reverted to an expected normal operation condition after a sludge discharge occasion the indication device 2 according to the invention checks the operation condition of the centrifugal separator 4 in the following manner. The control unit 28 closes almost simultaneously the inlet valve 34 and outlet valves 30 and when necessary also the outlet valve 33 during a predetermined period of time, which comprises one or a few seconds. This may result in that the pressure in the outlet conduit 12 temporarily increases somewhat over the operation pressure. If for instance the slide valve 24 is not tight the free liquid surface 44 of the separation chamber 8 will move radially outwardly and the oil in the oil outlet chamber 20 will be drained through the hole 21, which result in that the pressure sensor 32 senses a pressure reduction. This pressure reduction takes place faster with greater leakage past the slide valve 24.

If the pressure in the oil outlet conduit 12 has time to decrease during the predetermined period of time to a predetermined low pressure, which indicates a relatively large leakage, the control unit 28 activates the signal means 39 to generate an alarm signal. However, the centrifugal separator 4 may be in operation for some additional time with a satisfactory result. If the pressure in the oil outlet conduit 12 has time to decrease during the predetermined period of time to yet a lower pressure, which indicates unacceptable large leakage, the control unit 28 activates the signal means 39 to generate an alarm signal and keeps the inlet valve 34 closed even after the lapse of the predetermined period of time. In this case the centrifugal separator 4 is taken out of operation for service or repair.

Instead of sensing the pressure after a certain predetermined



period of time, it would be quite possible within the scope  
of the present invention to sense the course of pressure  
change continuously or at a plurality of time points during a  
predetermined period of time and to compare the sensed course  
5 of pressure change with a course of pressure change during  
normal operation conditions.

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**Claims**

**CLAIMS**

1. A method of indicating an undesired operation condition of a centrifugal separator (4), which includes a centrifugal rotor (6) forming a separation chamber (8), a supply conduit (10) for supplying a liquid mixture to be separated to the separation chamber, the liquid mixture containing at least two components, at least two outlets (18, 26) for discharging separated component, respectively, out of the separation chamber, one outlet (18) of the two outlets for discharging a separated liquid phase comprising one of the components, and an outlet conduit (12), the interior of which communicates with said one outlet (18), **characterised** by
- operating the centrifugal separator,
  - sensing a normal operation pressure in the outlet conduit (12), when a normal flow of the liquid mixture prevails in the supply conduit (10) and a normal flow of the liquid phase prevails in the outlet conduit (12),
  - at least substantially decreasing the flow of the liquid mixture through the supply conduit from the normal flow of the liquid mixture during a predetermined period of time,
  - at least substantially decreasing the flow of the liquid phase through the outlet conduit from the normal flow of the liquid phase during the same predetermined period of time,
  - sensing the course of the pressure change in the outlet conduit from the normal operation pressure during the predetermined period of time, and
  - generating an error signal in response to the sensed course of pressure change when this deviates from an expected normal course of pressure change.
2. A method according to claim 1, **characterised** in that the flow of the liquid phase through the outlet conduit (12) is closed during the predetermined period of time.

3. A method according to claim 1 or 2, **characterised** in that the flow of the liquid mixture through the supply conduit (10) is closed during the predetermined period of time.

5 4. A method according to any of claims 1-3, in which the second of the separated components constitutes sludge, a second outlet (26) of the centrifugal separator (4) is formed by a sludge discharge means (24) for intermittent discharge of the sludge, the centrifugal rotor (6) forms an outlet  
10 chamber (20) for said one component, and a paring disc (16) is arranged in the outlet chamber and forms said one outlet (18), **characterised** in that the error signal is generated if the pressure in the outlet conduit (12) decreases to a predetermined low pressure during the predetermined period of  
15 time.

5. A method according to claim 4, **characterised** in that the predetermined period of time, during which the course of pressure change in the outlet conduit (12) is sensed, begins  
20 as soon as the centrifugal separator (4) has reverted to an expected normal operation condition after a sludge discharging occasion.

6. A method according to claim 1 or 2, in which the second of  
25 the separated components is constituted by sludge and the second outlet of the centrifugal separator is formed by a sludge discharge means for continuous discharge of the sludge, **characterised** in that the error signal is generated if the pressure in the outlet conduit (12) decreases at a  
30 rate differing from an expected normal pressure decreasing rate during the predetermined period of time.

7. A device for indicating an undesired operation condition of a centrifugal separator (4) which comprises a centrifugal

rotor (6) forming a separation chamber (8), a supply conduit (10) for supplying a liquid mixture to be separated to the separation chamber, the liquid mixture containing at least two components, at least two outlets (18, 26) for discharging separated components, respectively, out of the separation chamber, one outlet (18) of the two outlets for discharging a separated liquid phase comprising one of the two components, and an outlet conduit (12), the interior which communicates with said one outlet (18), **characterised by**

- 10 - an inlet valve (34) situated in the supply conduit (10) and adjustable between open and closed positions,
- an outlet valve (30) situated in the outlet conduit (12) and adjustable between open and closed positions, the valves being adjustable in at least partly open normal valve
- 15 positions for passing normal flows through the supply and outlet conduits during normal operation of the centrifugal separator,
- a pressure sensor (32) for sensing the pressure in the outlet conduit upstream the outlet valve,
- 20 - a signal means (39) for generating an error signal, and
- a control unit (28) for activating the signal means to generate the error signal in response to the pressure sensor sensing during a predetermined period of time of the operation of the centrifugal separator a course of pressure
- 25 change in the outlet conduit differing from an expected normal course of pressure change, when the inlet and outlet valves during the predetermined period of time are adjusted in valve positions which at least substantially decreases the flows in the supply and outlet conduits from the normal flows
- 30 therein.

8. A device according to claim 7, **characterised** in that during the predetermined period of time the control unit (28) is adapted to activate the signal means (39) to generate the

error signal in response to the pressure sensor sensing a course of pressure change in the outlet conduit (12) differing from an expected normal course of pressure change, when the outlet valve (30) is closed and the inlet valve (34) is adjusted in a valve position which at least substantially decreases the flow in the supply conduit (10) from the normal flow therein.

9. A device according to claim 7, **characterised** in that during the predetermined period of time the control unit (28) is adapted to activate the signal means (39) to generate the error signal in response to the pressure sensor sensing a course of pressure change in the outlet conduit (12) differing from an expected normal course of pressure change, when the inlet and outlet valves (34, 30) are closed.

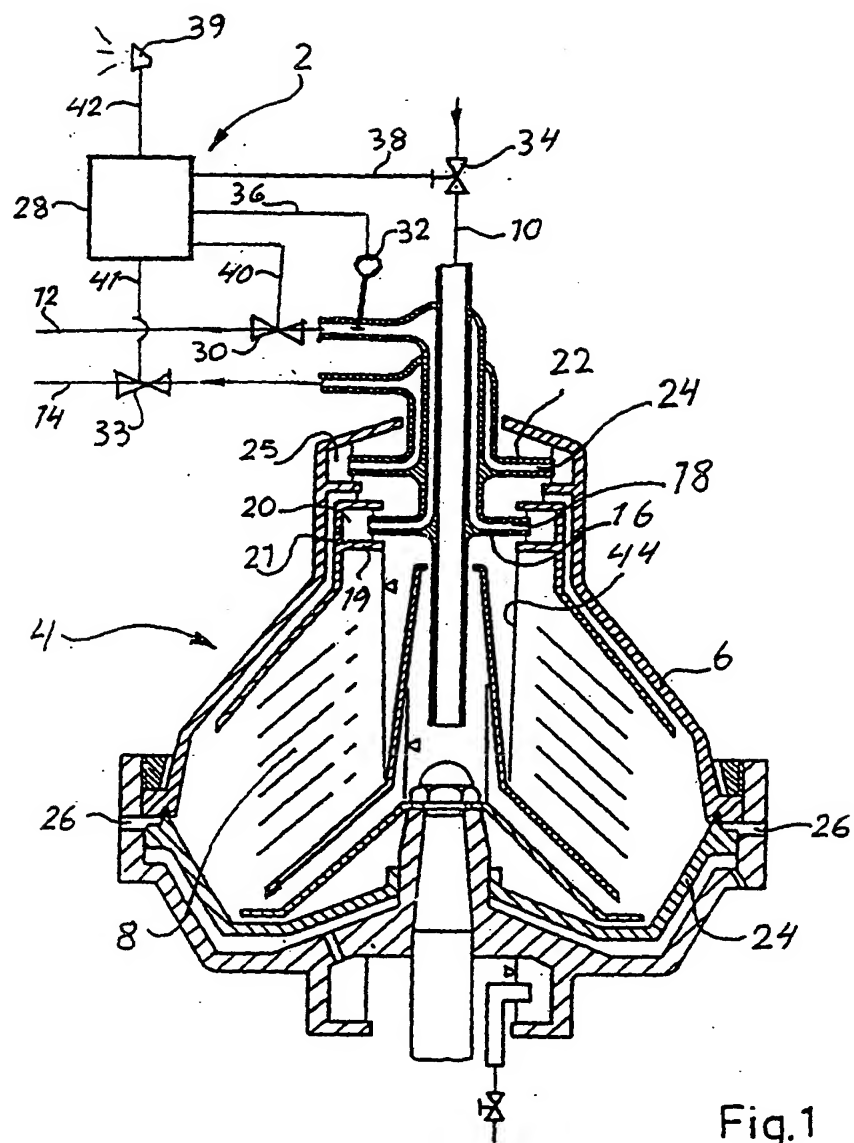
10. A device according to any of claims 7-9, in which the second of the separated components is constituted by sludge, the second outlet (26) of the centrifugal separator (4) is formed by a sludge discharge means (6, 24) for intermittent discharge of the sludge, the centrifugal rotor (6) forms an outlet chamber (20) for said one component, and a paring disc (16) is arranged in the outlet chamber and forms said one outlet (18), **characterised** in that during the predetermined period of time the control unit (28) is adapted to activate the signal means (39) to generate the error signal in response to the pressure sensor (32) sensing a pressure in the outlet conduit (12) which is below a predetermined pressure, which is lower than a normal operation pressure in the outlet conduit.

11. A device according to claim 7 or 8, in which the second of the separated components is constituted by sludge and the second outlet of the centrifugal separator (4) is formed by a

sludge discharge means for continuous discharge of the sludge, **characterised** in that during the predetermined period of time the control unit (28) is adapted to activate the signal means (39) to generate the error signal in response to the pressure sensor (32) sensing a pressure in the outlet conduit (12) which decreases at a rate differing from an expected normal pressure decreasing rate.

12. A device according to any of claims 5-7, **characterised** in that the control unit (28) controls the inlet valve (34) for adjusting the valve position thereof, and that during the predetermined period of time the control unit is adapted to activate the signal means (39) to generate the error signal and lock the inlet valve in a closed valve position in response to the pressure sensor (32) sensing a course of pressure change in the outlet conduit (12) differing to an unacceptably large extent from the expected normal course of pressure change.

13. A device according to any of claims 7-12, **characterised** in that the control unit (28) controls the outlet valve (34) for adjusting the valve position thereof.



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00424

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B04B 13/00 // B04B 1/10

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10272383 A (MITSUBISHI KAKOKI KAISHA) 1998-10-13 (abstract) World Patents Index (online). London, U.K.: Derwent Publications, Ltd. (retrieved on 2000-06-27). Retrieved from EPO WPI Database. DW9851, Accession No. 98-602336; & JP 10272383 A (MISUBISHI KAKOKI KAISHA LTD) 1998-10-13 (abstract) (online) (retrieved on 2000-06-27. Retrieved from: EPO PAJ Database; & JP 10-272383 (MITSUBISHI KAKOKI KAISHA) 1998-10-13, figur 1-5 --	1,7
A	US 4410318 A (J.E.G. BJÖRK ET AL), 18 October 1983 (18.10.83) --	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

28 June 2000

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00424

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International application No.

PCT/SE 00/00424

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